REMARKS/ARGUMENTS

Claims 1-22 are pending in this application.

Applicant notes with appreciation the indicated allowability of dependent claims 14-17.

Claims 1-4, 6-8, 10-12, 18, 19 and 21 were rejected for anticipation by and claims 5, 9, 13, 20 and 22 were rejected for obviousness over Fembök (6,075,238).

The present invention is for reliably detecting objects or persons that protrude into a monitored region, such as a safety zone at a dangerous machine, while preventing the triggering of undesired, erroneous signals resulting, for example, from vibrations or other events which do not constitute intrusions of objects into the monitored zone.

To accomplish this, the present invention records an actual image of the monitored region with a camera. The actual image of the monitored region is used to derive at least one actual measured value with information on differences between at least two different image regions of the monitored region and which is invariant with respect to image displacements, image rotations and/or image size changes.

The actual measured value is determined as follows (paragraph 0031 of Substitute Specification):

> At step 5, a derivation device of the evaluation unit can derive a measured value from such a structure which does not change, for example, with a pre-set, permitted displacement or rotation of the structure. With structure information including a grid structure, such a measured value can comprise the spacing of adjacent grid lines, the angle at which the grid lines intersect, the area enclosed by specific grid lines, etc. If the structure information comprises, for example, an area or an areal segment, the measured value can, for example, be equal to the surface integral.

This actual measured value is compared with a corresponding reference value derived from a stored reference image that was previously recorded by the camera. If the actual

measured value has a pre-set deviation from the reference value, that is, if the measured value exceeds a pre-established threshold reference value, an object recognition reaction is triggered.

Accordingly, claim 1 is limited amongst others to a method in which "at least one actual measured value is derived from the actually recorded image which provides information on differences between at least two different image regions and which is invariant with respect to image displacements ...; this actual measured value is compared with a corresponding reference value derived from a stored reference image", and a reaction is triggered when the difference exceeds a pre-set threshold or deviation of the measured value.

Similarly, apparatus claim 18 requires amongst others "a device for the derivation of at least one actual measured value from the actually recorded image, with the measured value supplying information on differences between at least two different image regions and being invariant with respect to image displacements ... and an object recognition stage for the triggering of an object recognition reaction on the finding of a pre-set deviation of the actual measured value from [a] reference value".

Thus, the present invention as defined by independent claims 1 and 18 prevents an unintentional triggering of reactions which may be caused by small movements of the camera and/or the monitored region. At the same time, it should be ensured that a reliable triggering of a reaction is guaranteed when an object actually intrudes into a protected space.

In other words, claims 1 and 18 of the present application relate to a method and apparatus, respectively, for the detection of an object moving in the monitored region of a camera wherein an actual image of the monitored region is recorded by the camera; and at least one actual measured value is derived from the actually recorded image, e.g. of the grid mentioned in paragraph 0031 of the Substitute Specification, which provides information on differences between at least two different image regions and which is invariant with respect to image displacements, image rotations and/or image size changes. This actual measured value, but not the image itself, is compared with a corresponding reference value derived from a stored

reference image recorded by the camera. Finally, an object recognition reaction is triggered on a pre-set deviation of the actual measured value from the reference value.

Summarized, the basic idea of the present invention is to generate a value from an actually captured image in a first step and, in a second step, to compare this generated value, but not the image itself, with a stored value of a reference image that was prepared in the same manner. These values are not influenced by small deviations of the captured image and/or the camera. Such small deviations can be caused, for example, by small displacements of the camera due to vibration of the camera.

Consequently, the invariant value of a captured image is generated during the first step by comparing different image regions in one and the same frame captured by the camera. The reference value is generated by comparing the different image regions of one and the same frame with the reference image. During the second step, the generated values are compared with each other.

The Fembök patent over which the claims were rejected for anticipation provides monitoring means which may be implemented at a moderate price, which has a reduced number of active elements, and which has a compact structure (column 1, lines 32-36).

Fembök discloses to use a light curtain having at one end of a monitoring region B a sensor means 8 which views a chessboard-like pattern field with alternating bright (white) 12 and dark (black) 14 areas via an objective 6. The monitoring region B of the light curtain can be extended by expanding the pattern field 4 and adding a corresponding number of optical means like reflectors 26 without adding further sensor means 8 (c.f. Fig. 2).

There is no suggestion in Fembök to generate a value from an actually captured image and to compare this generated value with a value of a corresponding reference image while these values are not affected by small deviations of the captured image and/or the camera.

The anticipation rejection of claims 1 and 18 relies on the observation that "The camera 8 determines the optical characteristics or intensities from the obtained image, which provide information on the differences between light area parts 14 and dark area parts 16". This

is not correct. The light area parts 12 and the dark area parts 14 of Fembök are provided to enhance the contrast between an intruding object and the background as is expressly set forth in column 4, lines 12-18, which states:

> A pattern field with light and dark area parts will ensure that even if the object intruding into the monitored area processes the same color or brightness (lightness) as for example the light area part, the intrusion of such object will nevertheless be detected, because the object will then also cover the dark area parts so that the detected optical characteristics will differ from those of the pattern field.

Column 3, lines 48-51, 55-59 and column 4, lines 6-10 of Fembök relied upon in the anticipation rejection of claim 1 do not disclose that the camera 8 determines an invariant measured value out of the light area parts 12 and dark area parts 14 within one and the same frame and comparing this value with another invariant measured value obtained in the same manner and stored as reference. Fembök only discloses that an actual pattern field can be stored in the monitoring means 10 (column 3, lines 51-54) and the detector detects the difference in lightness or in color when an object intrudes into the monitored region, as such object will as a rule possess a different degree of brightness or color to the light and/or dark area parts of the pattern field (column 4, lines 6-12). This means that an intruding object is detected by comparing an actual captured image, and not an actual measured value derived from the image as the present invention does, with a stored reference image. Thus, Fembök detects differences between the actual captured image itself, and not a value derived therefrom, and the reference image. As a result, small movements of the camera, for example due to vibrations, will be sensed and can result in an erroneous reading that an object entered the monitored zone.

Comparing an actually recorded image with a stored image by differentiating as disclosed by Fembök is part of the state of the art and, indeed, is discussed in paragraphs 0002 and 0003 of the Substitute Specification.

The difference between the present invention, as recited in independent claims 1 and 18, and Fembök is further demonstrated by the following example.

If in the device of Fembök the sensor 8 is touched lightly while capturing an image of the monitored region, the captured image becomes slightly displaced with respect to the reference image stored in the monitoring means 10. As a result, the grid created by the border lines of the chessboard pattern is displaced between the reference image and the actual captured image. When the actual captured image and the reference image are subtracted, the sensor 8 detects a grid-like structure created by the overlap of dark regions of the reference image and bright regions of the actual captured image and vice versa. This grid-like structure created by differentiating the reference image and the actual captured image will result in erroneously detecting an intruding object and triggering a reaction.

If the present invention as defined by independent claims 1 and 18 is applied in such a situation, no false reaction is triggered since the actually recorded image and the reference image are not directly compared. What is compared are a derived invariant value of the actually recorded image and a corresponding derived invariant value of the reference image, e.g. a quantified brightness difference between a light area part 12 and a dark area part 14 of the chessboard pattern which is generated separately for the reference image and the actually captured image. The two do not change as a result of small movements of the sensor 8.

Claim 1 recites that an "actual measured value is derived from the actually recorded image ... which is invariant with respect to image displacements ... [and] this actual measured value is compared with a corresponding reference value ...." Claim 18 has the same limitation but employs apparatus terminology.

Since Fembök contains no disclosure at all to compare values derived from actually recorded images, instead of comparing the images themselves, Fembök does not anticipate claims 1 and 18.

The remaining claims 2-17 and 19-22 are directed to specific features of the present invention which are independently patentable. These claims are further allowable because they depend from allowable parent claims.

CONCLUSION

In view of the foregoing, applicants submit that this application is in condition for allowance, and a formal notification to that effect at an early date is requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at (415) 576-0200.

Respectfully submitted,

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